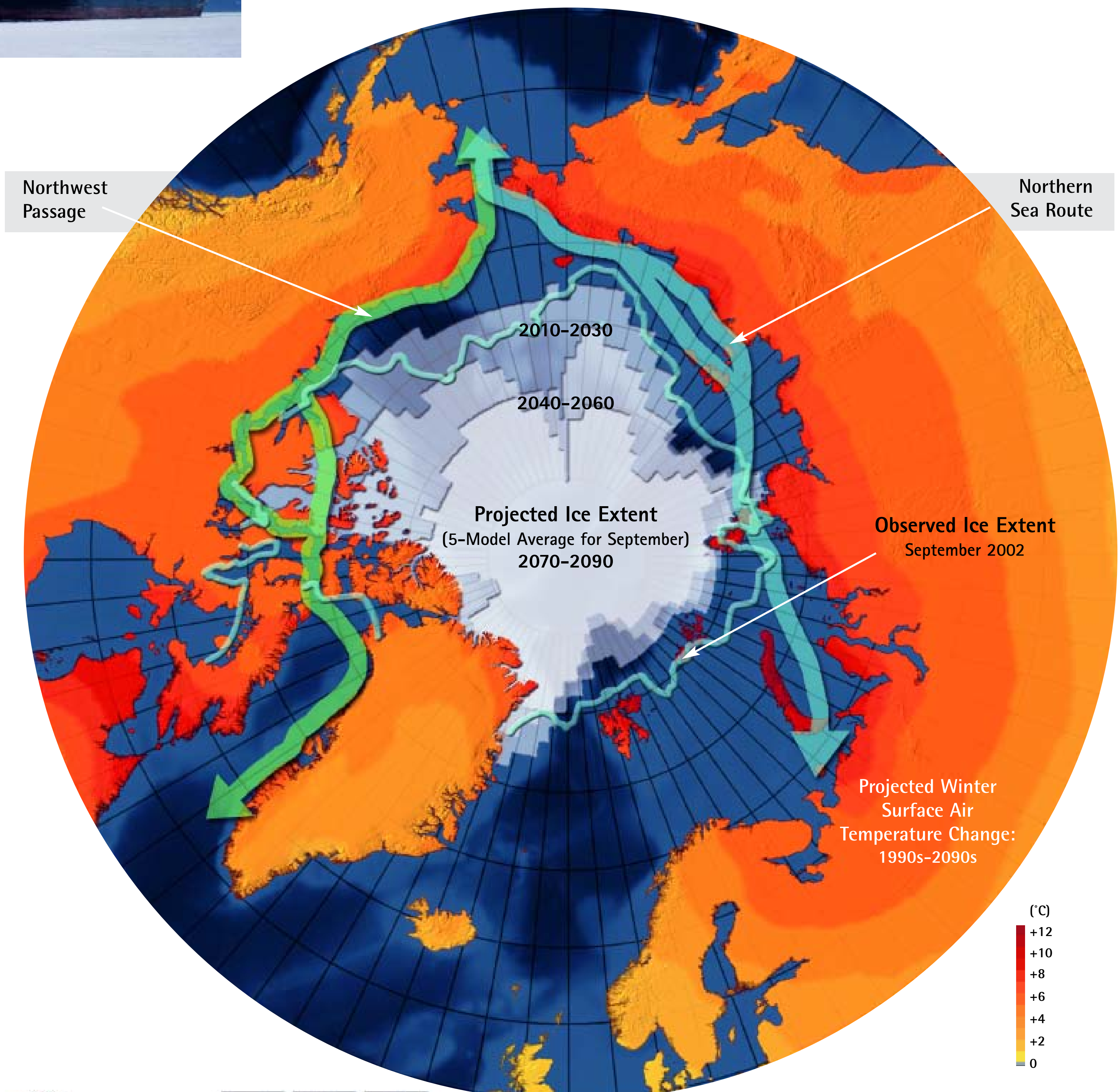
6 Reduced sea ice is very likely to increase marine transport and access to resources.

Observations over the past 50 years show a decline in arctic sea-ice extent in all seasons, with the most prominent retreat in summer. Recent studies estimate arctic-wide reductions in annual average sea-ice extent of about 5-10% and a reduction in average thickness of about 10-15% over the past few decades. Measurements taken by submarine sonar in the central Arctic Ocean revealed a 40% reduction in ice thickness in that area. Taken together, these trends indicate an Arctic Ocean with longer seasons of less sea-ice cover of reduced thickness, implying improved ship accessibility around the margins of the Arctic Basin (although this will not be uniformly distributed).



Climate models project an acceleration of this trend, with periods of extensive melting spreading progressively further into spring and autumn. Model projections suggest that sea ice in summer will retreat further and further away from most arctic landmasses, opening new shipping routes and extending the period during which shipping is feasible.

The navigation season is often defined as the number of days per year in which there are navigable conditions, generally meaning less than 50% sea ice concentration. The navigation season for the Northern Sea Route is projected to increase from the current 20-30 days per year to 90-100 days by 2080. Passage is feasible for ships with ice-breaking capability in seas with up to 75% sea-ice concentration, suggesting a navigation season of approximately 150 days a year for these vessels by 2080. Opening of shipping routes and extending the navigation season could have major implications for transportation as well as for access to natural resources.

The Northern Sea Route

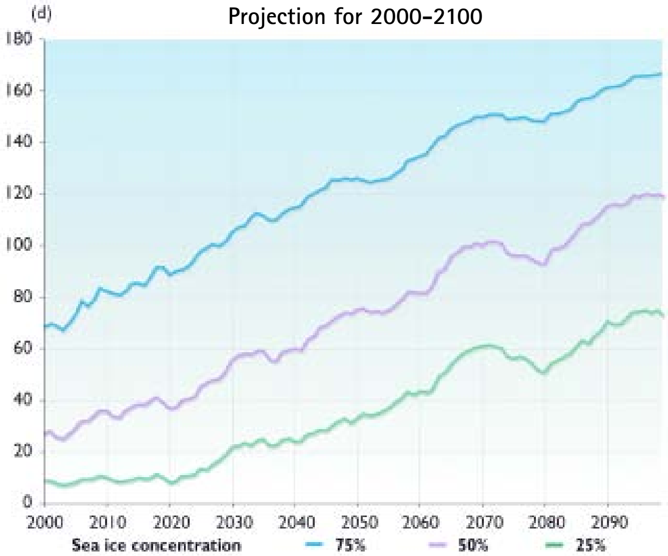
The Northern Sea Route (NSR) is the formal Russian name for the seasonally ice-covered marine shipping routes across the north of Eurasia from Novaya Zemlya in the west to the Bering Strait in the east. The NSR is administered by the Russian Ministry of Transport and has been open to marine traffic of all nations since 1991. For trans-Arctic voyages, the NSR represents up to a 40% savings in distance from northern Europe to northeastern Asia and the northwest coast of North America compared to southerly routes via the Suez or Panama Canals.

The NSR also provides regional marine access to the Russian Arctic for ships sailing north from Europe and eastward into the Kara Sea and returning westward to Europe or North America. Regional access from the Pacific side of the NSR is achieved when ships sail through the Bering Strait to ports in the Laptev and East Siberian Seas and return eastward to Asia with cargo. Since 1979, year-round navigation has been maintained by Russian icebreakers in the western region of the NSR, providing a route through Kara Gate and across the Kara Sea to the Yenisey River.

The Russian Arctic holds significant reserves of oil, natural gas, timber, copper, nickel, and other resources that may best be exported by sea. Regional as well as trans-Arctic shipping along the NSR is very likely to benefit from a continuing reduction in sea ice and lengthening navigation seasons.

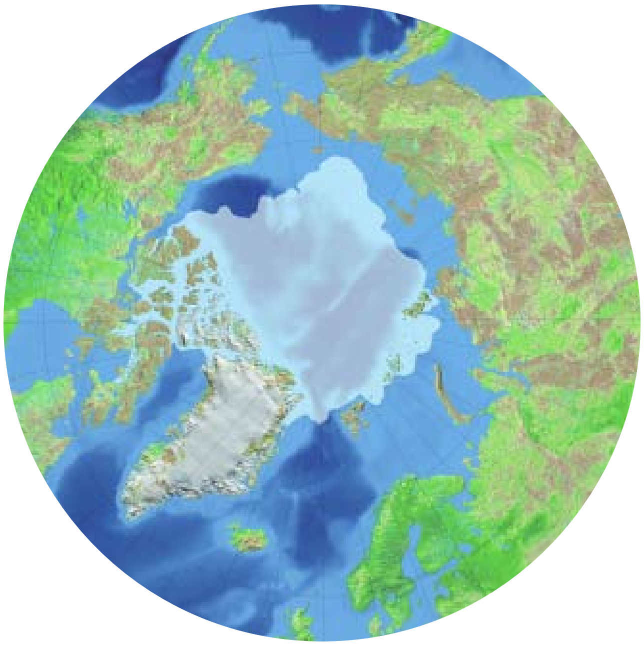
The satellite image of sea-ice extent for September 16, 2002 provides a good illustration of marine access around the Arctic Basin. Such low summer minimum ice extents create large areas of open water along much of the length of the NSR. The further north the ice edge retreats, the further north ships can sail in open water on trans-Arctic voyages, thereby avoiding the shallow shelf waters and narrow straits of the Russian Arctic.

Northern Sea Route Navigation Season
Projection for 2000-2100



The graph shows the projected increase in days of the navigation season through the Northern Sea Route as an average of five ACIA model projections.

Observed Sea Ice Cover
September 16, 2002



6 Reduced sea ice is very likely to increase marine transport and access to resources.

Sovereignty, Security, and Safety

As the decline in arctic sea ice opens historically closed passages, questions are likely to arise regarding sovereignty over shipping routes and seabed resources. Issues of security and safety could also arise. One impact of the projected increase in marine access for transport and offshore development will be requirements for new and revised national and international regulations focusing on marine safety and environmental protection. Another probable outcome of this growing access will be an increase in potential conflicts among competing users of arctic waterways and coastal seas, for example, in the Northern Sea Route and Northwest Passage. Commercial fishing, sealing, hunting of marine wildlife by indigenous people, tourism, and shipping all compete for use of the narrow straits of these waterways, which are also the preferred routes for marine mammal migration.

New and revised national and international regulations focusing on marine safety and environmental protection will be necessary.

With increased marine access in arctic coastal seas – for shipping, offshore development, fishing, and other uses – national and regional governments will be called upon for increased services such as icebreaking assistance, improved ice charting and forecasting, enhanced emergency response in dangerous situations, and greatly improved oil-ice cleanup capabilities. The sea ice, while thinning and decreasing in extent, is likely to become more mobile and dynamic in many coastal regions where fast ice and relatively stable conditions previously existed. Competing marine uses in newly open or partially ice-covered areas will call for increased enforcement presence and regulatory oversight.

Increasing access in the Arctic Ocean will require ships transiting the region to be built to higher construction standards compared with ships operating in the open ocean. International and domestic regulations, designed to enhance maritime safety and marine environmental protection in arctic waters, will need to take into account that each ship will have a high probability of operating in ice somewhere during a voyage. Such ships will have higher construction, operational, and maintenance costs.

Sea Ice Changes Could Make Shipping More Challenging

Not all agree that reduced sea ice, at least in the early part of the 21st century, will necessarily be the boon to shipping that is widely assumed. Recent sea ice changes could, in fact, make the Northwest Passage less predictable for shipping. Studies by the Canadian Ice Service indicate that sea ice conditions in the Canadian Arctic during the past three decades have been characterized by high year-to-year variability; this variability has existed despite the fact that since 1968-1969 the entire region has experienced an overall decrease in sea-ice extent during September. For example, in the eastern Canadian Arctic, some years – 1972, 1978, 1993, and 1996 – have had twice the area of sea ice compared with the first or second year that follows. This significant year-to-year variability in sea ice conditions makes planning for regular marine transportation along the Northwest Passage very difficult.

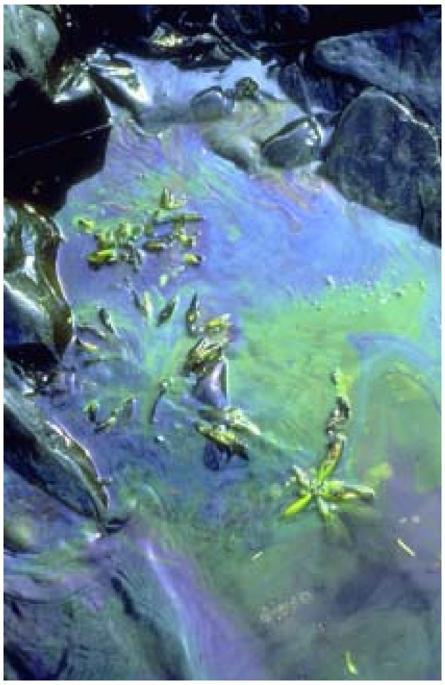
In addition, results of research at Canada's Institute of Ocean Sciences suggest that the amount of multi-year sea ice moving into the Northwest Passage is controlled by blockages or "ice bridges" in the northern channels and straits of the Canadian Arctic

Archipelago. With a warmer arctic climate leading to higher temperatures and a longer melt season, these bridges are likely to be more easily weakened (and likely to be maintained for a shorter period of time each winter) and the flushing or movement of ice through the channels and straits could become more frequent. More multi-year ice and potentially many more icebergs could thus move into the marine routes of the Northwest Passage, presenting additional hazards to navigation. Thus, despite widespread retreat of sea ice around the Arctic Basin, it is clear that the unusual geography of the Canadian Arctic Archipelago creates exceptionally complex sea ice conditions and a high degree of variability for the decades ahead.

Oil Spills: An Example of the Risks That Accompany Increasing Access

Along with increasing access to shipping routes and resources comes an increasing risk of environmental degradation caused by these activities. One obvious concern involves oil spills and other industrial accidents. A recent study suggests that the effects of oil spills in a high-latitude, cold ocean environment last much longer and are far worse than first suspected.

In 1989, the Exxon Valdez oil tanker slammed into a reef while maneuvering to avoid ice in the shipping lanes and poured 42 million liters (11 million gallons) of crude oil into Alaska's Prince William Sound. The spill was the worst tanker disaster ever in U.S. waters, killing at least 250 000 seabirds and thousands of marine mammals. It forced the closure of commercial fishing grounds and areas traditionally used to gather wild foods. Scientists knew the immediate effects would be devastating but some predicted the environment would recover as soon as the oil weathered and dissipated. Instead, they found that marine life suffered for many years, and continues to suffer, because even tiny patches of remnant oil reduced survival, slowed reproduction, and stunted growth. Lingering oil has created cascading problems for fish, seabirds, and marine mammals.



The recent study found that Valdez oil was still embedded in Prince William Sound beaches in the summer of 2003. "The oil is oozing into holes," said Stanley Rice of the National Marine Fisheries Service laboratory in Juneau, Alaska, who led a team that dug about 1000 pits in beaches in 2003. "There, the oil is like it was two or three weeks after the spill." Sea otters and other animals digging for food are exposed to the oil and its ill effects, Rice said. Studies of sea otters, harlequin ducks, salmon, and shellfish suggest that patches of oil that persist on some beaches release enough hydrocarbons to cause chronic problems that will continue for some species for many years.

Experts say that the overall strategy for arctic spills must be preventative. New regulations for ships, offshore structures, port facilities, and other coastal activities must be designed to reduce the risk of spills through enhanced construction standards and operating procedures. Nevertheless, spills are expected, and spill response operations in the Arctic will be more complex and demanding in ice-covered waters than in Prince William Sound or open seas, especially since effective response strategies have yet to be developed.